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**REMARKS**

Claim 1 has been amended to delete " $\text{Mo}(\text{Si}_{1-y}\text{Al}_y)_2$ " and to incorporate the subject matter of claim 2. Consequently, claim 2 has been canceled without prejudice or disclaimer. Additionally, claims 10 and 11 have each been amended to depend from claim 1 instead of from claim 2.

Each of the claims was rejected as indefinite based upon the inadvertent retention in claim 1 of the term " $\text{Mo}(\text{Si}_{1-y}\text{Al}_y)_2$ ." That term has been canceled and therefore the alleged indefiniteness based thereon has been overcome.

Claims 1, 4 through 6, 8, and 9 were rejected as obvious based upon a combination of the Schrewelius '145 and '959 references, together with the Sekhar et al. '399 reference. And claims 2 and 10 were rejected as obvious based upon those same references together with the Chyung et al. '091 reference. Because the subject matter of claim 2 has been incorporated into claim 1, the following discussion will be based upon claim 1 as hereinabove amended. Further, the subject matter recited in claim 2 is referred to in paragraph [0021] of the substitute specification.

With regard to the Schrewelius '145 reference, it should at first be noted that that reference is directed to a thermocouple alloy, not to an electrical heating element. It is also important to note that the Schrewelius '145 reference teaches the use of bentonite as the ceramic binding substance for the composition for each of the legs of the thermocouple that is the subject of that reference (see Schrewelius '145, col. 3, line 3 for the teaching of bentonite as a component of the positive leg of the thermocouple and line 15 for the teaching of bentonite as a component negative

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leg of the thermocouple). Thus, in addition to the Schrewelius '145 reference failing to disclose molybdenum aluminum silicide mixed in combination with  $\text{SiO}_2$  having at least 98% purity, as specifically recited in claim 1, it also teaches the use of bentonite, which claim 1 excludes from the composition produced by the claimed method, as well as from the claimed electrical heating element of claim 6. Thus, the Schrewelius '145 reference teaches away from the invention as it is claimed in amended claim 1. Moreover, as was pointed out above, Schrewelius '145 relates to a thermocouple element, which is considerably different from a heating element. A thermocouple element does not have the peeling problem.

Furthermore, it is noteworthy that in the first paragraph on page 7 of the Action the examiner specifically admitted that the Schrewelius '145 reference does not disclose:

...the product being formed by the method also consisting essentially of (i.e. comprising)  $\text{Al}_2\text{O}_3$ ; and the  $\text{SiO}_2$  being at least 98% pure and the heating element being free of bentonite; and the oxide layer not peeling under thermal cycling at about  $1500^\circ\text{C}$ , whereby heating oven contamination in the form of peeled heating element oxide layer particles in a heating oven containing the heating element *is prevented*. (emphasis in original)

Reference was then made to the Schrewelius '959 reference.

With regard to the Schrewelius '959 reference, the second paragraph on page 5 of the Action contains several statements concerning that reference that are not supported by the text of that reference. First of all, it was said in the Action that the Schrewelius '959 reference "teaches a method of producing a molybdenum-silicide-type heating element in which a  $\text{Al}_2\text{O}_3$  product is formed via the chemical reaction to form a ceramic glass component that efficiently stops the grain growth of

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the silicide at high temperatures (column 5, lines 69-75; column 6, lines 1-7)." But the glass component is not formed from  $\text{Al}_2\text{O}_3$ . As stated in the Schrewelius '959 reference at col. 2, lines 44 -50, it is quartz glass that is formed, and that it protects the element material from further oxidation. And in the sentence bridging cols. 2 and 3 it is stated that the ceramic glass compound is a film of silicon dioxide. The film is formed by Si coming out to the surface from the element material and is oxidized on the surface to form the quartz glass film of  $\text{SiO}_2$ . In the same way some Al is coming to the surface and is oxidized. The surface layer or film does not essentially consist of  $\text{Al}_2\text{O}_3$ , as stated in the Action, but it will essentially consist of  $\text{SiO}_2$ . In that regard, see col. 5, line 75, where the analysis is 34.9% Si and 0.7% Al. Additionally, if the  $\text{Al}_2\text{O}_3$  is a constituent that undergoes reaction with  $\text{SiO}_2$ , as taught by the Schrewelius '959 reference, it is no longer present as  $\text{Al}_2\text{O}_3$  because the outer layer is "mainly aluminum silicate," also as taught by that reference.

Secondly, regarding the matter of peeling of the oxide layer under thermal cycling, which the claimed invention overcomes, the Schrewelius '959 reference only refers to a constant temperature (col. 7, lines 46-49), and not to thermal cycling. Therefore, the different, silica glass coating taught by that reference was not disclosed as having been subjected to thermal cycling, and it cannot be concluded that it would not peel if subjected to that condition.

The Sekhar et al. reference was relied upon for disclosing the use of pure  $\text{SiO}_2$ . However, the disclosure of the use of pure  $\text{SiO}_2$  to raise the working temperature range of a heating element says nothing about thermal cycling or about peeling of a surface layer. All the temperature tests disclosed in that reference

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appear to have been run under steady state conditions. Further, in the paragraph bridging pages 7 and 8 of the Action mentioning the Schrewelius '145 reference, reference was made to the operating temperature disclosed in that reference, but, again, that reference also says nothing about thermal cycling or about peeling of a surface layer. And concerning the mention in that same paragraph of Sekhar et al. using pure  $\text{SiO}_2$  instead of bentonite in Example 12, that example is based upon composition AA, which is identified at col. 7, line 66 to col. 8, line 8, and which does not identify an outer layer of  $\text{Al}_2\text{O}_3$ , and thus it cannot relate to peeling of such an outer layer, or to thermal cycling of a heating element having such an outer layer.

On page 8 of the Action, at the middle of the first paragraph, it is concluded that it would have been obvious to modify the Schrewelius references by replacing bentonite with the pure  $\text{SiO}_2$  disclosed by the Sekhar et al. reference. But in Process II at column 10 of the Sekhar et al. reference, in which bentonite is mentioned, and in Example 1 at column 13 the material is composition U, which includes bentonite, and which is processed in accordance with Process II. Moreover, Example 1 was a steady state test that was run at  $1600^\circ\text{C}$  for 40 hours, and it did not disclose or suggest thermal cycling operation, which would not have produced peeling of an outer layer of the heating elements. Thus, the person of only ordinary skill in the art would be led by that combination of references to utilize bentonite, which is also the material of the Schrewelius references, and not the pure  $\text{SiO}_2$ . And none of those references discloses or suggests the effects of thermal cycling of heating elements. Because they each fail to appreciate the problem, they cannot be said to teach or suggest a solution to such an unappreciated problem.

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The Chyung et al. '091 reference was cited against former claim 2 merely for a disclosure of mullite. However, the Chyung et al. '091 reference also lacks those features recited in amended claim 1 that are noted in the discussion above relative to the Schrewelius '145 and '959 references and the Sekhar et al. '399 reference. At col. 2, line 63 to col. 3, line 1 of the Chyung et al. reference, it is necessary that there be "crystallization promoting agents" and that the "glass-ceramic chosen for use in the cermet must be chemically compatible with the alloy chosen for the metallic phase". Those two statements do not at all indicate that it is a "silicate that does not affect molybdenum silicide crystal lattice symmetry," as claimed in the portion of amended claim 1 that incorporates the subject matter of former claim 2. Additionally, the statements of the Chyung et al. reference referred to on page 10 of the Action, as well as the recitations in claim 9 of that reference are both silent with respect to the subject matter of former claim 2. Thus, the Chyung reference does not disclose the subject matter recited in amended claim 1 that is carried over from former claim 2.

Accordingly, the addition of the Chyung et al. reference to the other references that were relied upon still does not teach or even suggest the invention as it is claimed in amended claim 1, or in claim 10 that depends from amended claim 1. Again, however, there are no disclosures in any of the references relied upon that would lead one having only ordinary skill in the art to combine them in any way at all, let alone to arrive at the claimed invention. And it is not apparent from the references just which parts of which reference should be combined with which parts of the other references and which parts of the references should be ignored or discarded. Indeed, it appears that the only motivation for even

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selecting the references and then combining them in a particular way is the present disclosure. But it is improper to use as a road map or a template an inventor's disclosure in order to use against him that which only he has disclosed.

Claim 11 was rejected as obvious based upon the combination of the Schrewelius '145 and '959 references, together with the Sekhar et al. '399 and the Chyung et al. '091 references, in view of the Sawamura et al. '215 reference. The Sawamura et al. '215 reference was cited for disclosing sillimanite. But that reference also lacks the teaching or suggestion of the factors discussed above in connection with the other references and that are recited in amended claim 1. Therefore, even if the Sawamura et al. '215 reference were to be combined with the other references that are relied upon by the examiner, that combination still does not teach or suggest the invention as claimed in claim 1, from which claim 11 indirectly depends.

In addition to the differences in materials and in the differences in the problems to which the individual references are directed, there are no disclosures in any of the references relied upon that would motivate one having only ordinary skill in the art to combine them in any way at all, let alone to arrive at the claimed invention. Because the problem addressed by the present invention is not mentioned in the references and is different from the problems to which the references are addressed, one of only ordinary skill in the art would not be led to those references for a solution to the problem of the peeling of an  $\text{Al}_2\text{O}_3$  outer surface layer of a heating element that is subjected to thermal cycling between room temperature and 1500°C.

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Additionally, even if one of only ordinary skill in the art were to consider the references relied upon, is not apparent from the references just which parts of which reference should be combined with which parts of the other references and which parts of the references should be ignored or discarded. Indeed, it appears that the only motivation for even selecting the references, and then combining them in a particular way is the present disclosure. But it is improper to use as a road map or a template an inventor's disclosure in order to use against him that which only he has disclosed.

Claim 1 clearly recites an  $\text{Al}_2\text{O}_3$  surface layer that does not peel under thermal cycling between room temperature and about  $1500^\circ\text{C}$ . None of the references relied upon discloses or suggests an  $\text{Al}_2\text{O}_3$  surface layer, nor do any of the references even mention or appreciate the peeling problem to which the present invention is directed. In fact, the Sekhar et al. reference teaches away from the invention as it is claimed in amended claim 1. Thus, whether the references are considered alone or together, neither the individual references nor any attempted combination of them teaches or suggests the invention as it is claimed in amended claim 1, from which each of the other claims in the application depends, either directly or indirectly.

The Declaration Under 37 CFR 1.132 of coinventor Mats Sundberg that was filed herein together with the previous AMENDMENT provides the results of testing that was conducted on molybdenum silicide heating elements that were thermally cycled between room temperature and temperatures of from  $1400^\circ\text{C}$  to  $1565^\circ\text{C}$ . Compositions including different constituents containing  $\text{SiO}_2$  were formed, tested,

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and evaluated from the standpoint of adhesion to the resulting heating elements of outer layers of  $\text{Al}_2\text{O}_3$ . In the examples described in paragraphs 3 and 7 the  $\text{SiO}_2$  was provided in the form of bentonite, having 60%  $\text{SiO}_2$ , and in the examples described in paragraphs 4, 5, and 6 the  $\text{SiO}_2$  was provided as a powder containing at least 98%  $\text{SiO}_2$ . In each of the tests in which the tested heating elements were prepared using bentonite as the source of  $\text{SiO}_2$  (paragraphs 3 and 7) and thermally cycled, the resulting  $\text{Al}_2\text{O}_3$  outer layer flaked and exhibited spalling (paragraph 3), or was fragile and porous (paragraph 7). But in the tests involving heating elements prepared using  $\text{SiO}_2$  powder containing 98%  $\text{SiO}_2$ , after thermal cycling the resulting heating elements included  $\text{Al}_2\text{O}_3$  outer layers that in each case adhered to the heating material surfaces and did not flake off (paragraphs 4, 5, and 6). The results of those tests show that the adhesion to the heating element surfaces of heating elements prepared using 98% pure  $\text{SiO}_2$  when subjected to thermal cycling between high temperatures of the order of about  $1560^\circ\text{C}$  and room temperature were clearly superior to those prepared using bentonite as the source of  $\text{SiO}_2$ .

Finally, the corresponding European application stemming from the same PCT application as the present U.S. application has been allowed and has issued as EP 1 492 739. A copy of that patent is attached and evidences that the European examiner concluded that the claims as published as part of that patent satisfied each of the novelty, inventive step (nonobviousness), and commercial applicability criteria set forth in the Patent Cooperation Treaty.

Based upon the foregoing amendments and remarks, the claims as they now stand in the application are believed clearly to be in allowable form in that they



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patentably distinguish over the disclosures contained in the references that were cited and relied upon by the examiner, whether those references be considered alone or together. Consequently, this application is believed now to be in condition for allowance, and reconsideration and reexamination of the application is respectfully requested with a view toward the issuance of a Notice of Allowance.

The courtesy of an interview is requested if this amendment is not deemed to place the present application in condition for allowance. And in that event, the examiner is invited to telephone the undersigned to arrange a convenient time for such an interview.

Respectfully submitted,



October 27, 2009

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(54) METHOD OF MAKING A HEATING ELEMENT OF THE MOLYBDENUM SILICIDE TYPE AND A HEATING ELEMENT

VERFAHREN ZUR HERSTELLUNG EINES HEIZELEMENTS VOM MOLYBDÄNSILIZID-TYP UND HEIZELEMENT

PROCEDE DE FABRICATION D'UN ELEMENT DE CHAUFFAGE DU TYPE SILICIURE DE MOLYBDENE ET ELEMENT DE CHAUFFAGE

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(56) References cited:  
GB-A- 795 004 SE-C- 204 116  
US-A- 3 289 806 US-A- 4 555 358

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## Description

[0001] The present invention relates to a method of manufacturing a heating element of the molybdenum silicide type and also to a heating element.

[0002] An electrical resistance element of the molybdenum silicide type is described in Swedish Patent Specifications 0003512-1 and 0004329-9. According to patent specification 0003512-1 the resistance material of the heating element includes  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  which is caused to contain aluminium to an extent at which the formation of pest is essentially prevented.

[0003] It has been found that when such material is operated in a temperature range of 400 - 800°C no pest, or only a slight amount of pest, is formed. Pest is formed by virtue of the formation of  $\text{MoO}_3$  from  $\text{MoSi}_2$  and  $\text{O}_2$ .

[0004] The reason why the formation of pest is significantly reduced or is eliminated is due to the formation of  $\text{Al}_2\text{O}_3$  on the surface of the element.

[0005] According to one preferred embodiment x is caused to lie in the range of 0.2 - 0.6.

[0006] The other patent specification 0004329-9 teaches a method of increasing the useful life span of heating elements that consist chiefly of molybdenum silicide and alloys of this basic material where the element operates at high temperatures.

[0007] According to this patent specification, the heating element is caused to contain aluminium to an extent which is sufficient to maintain a stable, slowly growing layer of aluminium oxide on the surface of the heating element.

[0008] According to a preferred embodiment the heating element material is caused to contain  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  where x lies in the range of 0.2 - 0.6.

[0009] A material of the molybdenum silicide type that contains aluminium has been found to possess improved corrosion properties at both low and high temperatures.

[0010] Such material is often produced by mixing  $\text{MoSi}_2$  powder with oxidic raw material, such as aluminosilicates. When the raw material is bentonite clay, there is obtained a relatively low melting point which contributes towards so-called smelt phase sintering which results in a dense material that contains  $\text{MoSi}_2$  and a proportion of aluminium silicate corresponding to 15 - 20 percent by volume.

[0011] Bentonite clay has different compositions. Some bentonites include 60% by weight  $\text{SiO}_2$  while some contain somewhat more than 70% by weight  $\text{SiO}_2$ . Although the  $\text{Al}_2\text{O}_3$  content varies, it normally lies between 13 - 20% by weight. The melting point varies between about 1200 - 1400°C.

[0012] Bentonite clay that contains chiefly  $\text{SiO}_2$  can be used in the production of heating elements containing  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$ . When sintering with an Al-alloyed silicide there takes place a chemical exchange reaction in which the greater affinity of the oxygen to Al than to Si results in Si leaving the aluminium silicate and entering the silicide as a result of Al leaving the silicide and being sucked

up by the oxide phase. This exchange reaction also contributes towards improved sintering properties of the composite material. The final material contains  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  that is substantially depleted of Al, where the oxide phase contains  $\text{Al}_2\text{O}_3$  in all essentials.

[0013] The standard procedure of manufacture involves mixing molybdenum, silicon and aluminium in powder form and firing the powder mix normally under a shielding gas atmosphere. This results in a cake of the material  $\text{Mo}(\text{Si}_{1-y}\text{Al}_y)_2$ , where y is larger than x in the above formula as a result of said exchange reaction. The reaction is exothermic. The cake is then crushed and ground down to a fine particle size normally in the order of 1 - 20 µm. This powder is mixed with bentonite clay such as to form a wet ceramic material. The material is extruded and dried to a rod form whose diameter corresponds to the diameter of the subsequent element. The material is then sintered at a temperature that exceeds the melting temperature of the including components.

[0014] However, there is a drawback with an element of this kind. The problem is that the oxide that forms on the surface of the element, namely  $\text{Al}_2\text{O}_3$ , sometimes peels away or flakes off, i.e. loosens from the surface of the element in the case of cyclic operation.

[0015] A peeling oxide gives poorer protection against continued oxidation of aluminium which becomes impoverished in the outer surface of the element more quickly. Moreover, a peeling oxide can contaminate the oven in which the element is fitted, with the risk that performance and the appearance of products heat treated in ovens that have such elements will be significantly impaired. This restricts the use of such elements in heating processes.

[0016] This problem is solved by the present invention.

[0017] The present invention thus relates to a method of producing a heating element substantially comprising of the molybdenum silicide type and alloys of this basic material, and is characterized by producing a material that substantially contains  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  and  $\text{Al}_2\text{O}_3$  by mixing a molybdenum aluminosilicide  $\text{Mo}(\text{Si}_{1-y}\text{Al}_y)_2$  with  $\text{SiO}_2$  wherein  $\text{SiO}_2$  has a purity of at least 98%.

[0018] Further, the invention relates to a heating element of the kind and with the main features as indicated in claim 6.

[0019] The invention will now be described in more detail in the following.

[0020] In accordance with the invention a heating element that consists chiefly of molybdenum silicide type and alloys of this basic material is produced by mixing a powder that chiefly contains  $\text{Mo}(\text{Si}_{1-y}\text{Al}_y)_2$  with highly pure  $\text{SiO}_2$ . Pure silicon dioxide has a melting temperature of about 1700°C. When using  $\text{SiO}_2$  however, said exchange reaction between Si in the oxide and Al in the silicide results in a high density sintered product.

[0021] The mentioned  $\text{SiO}_2$  can be present as pure  $\text{SiO}_2$  or as an aluminium silicate of high purity. However,  $\text{SiO}_2$  can be included in silicates in which other substances in the silicate have properties which prevent the mo-

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lybdenum silicide from being alloyed with the substance or substances concerned and with which the symmetry of crystal lattice of the molybdenum silicide will be retained. Mullite and sillimanite are examples of conceivable material in this regard.

[0022] The present invention thus replaces the bentonite clay with silicon dioxide, therewith excluding the transfer of impurities in the bentonite clay, such as Mg, Ca, Fe, Na and K, to the heating element, thus eliminating the negative effects of such impurities on the function of said element.

[0023] It is possible to partly substitute molybdenum with Re or W in the material  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  without changing the symmetry of the crystal lattice.

[0024] It has been found surprisingly that there is obtained with low contaminant contents an oxide which does not peel after cyclic operation between room temperature and high temperatures, for instance 1500°C.

[0025] According to one embodiment x is caused to lie in the range of 0.4 - 0.6.

[0026] According to one preferred embodiment x is caused to lie in the range of 0.45 - 0.55.

[0027] The present invention thus solves the problem mentioned in the introduction and enables the present element to be used beneficially in ovens without detriment to the material treated in the oven.

[0028] The present invention shall not be considered to be limited to the aforescribed embodiments, since variations can be made within the scope of the accompanying claims.

#### Claims

1. A method of producing a heating element that is comprised essentially of molybdenum silicide type and alloys of this basic material, characterized by producing a material that contains substantially  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  and  $\text{Al}_2\text{O}_3$  by mixing a molybdenum aluminum silicide  $\text{Mo}(\text{Si}_{1-y}\text{Al}_y)_2$  with  $\text{SiO}_2$ , wherein the  $\text{SiO}_2$  is at least 98% pure.
2. A method according to Claim 1, characterized in that the  $\text{SiO}_2$  is present in silicates, such as mullite and sillimanite, which do not effect the symmetry of the crystal lattice of molybdenum silicide.
3. A method according to Claim 1 or 2, characterized in that x is caused to lie in the range of 0.4 - 0.6.
4. A method according to Claim 1 or 2, characterized in that x is caused to lie in the range of 0.45 - 0.55.
5. A method according to Claim 1, 2, 3 or 4, characterized by substituting molybdenum partly with Re or W in the material  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$ .
6. A electrical heating element that is comprised sub-

stantially of the molybdenum silicide type and alloys of this basic material, characterized in that said elements is comprised chiefly of the materials  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  and  $\text{Al}_2\text{O}_3$ ; wherein  $\text{SiO}_2$  having a purity of at least 98% is added during the production process.

7. A heating element according to Claim 5, characterized in that x lies in the range of 0.4 - 0.6.

8. A heating element according to Claim 7, characterized in that x is caused to lie in the range of 0.45 - 0.55.

9. A heating element according to Claim 5, 6, 7 or 8, characterized in that molybdenum in the material  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  is replaced partially with Re or W.

#### Patentansprüche

1. Verfahren zum Herstellen eines Heizelements, welches im Wesentlichen aus Molybdänsilicid und Legierungen dieses Grundmaterials besteht, gekennzeichnet durch Herstellen eines Materials, welches im Wesentlichen  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  und  $\text{Al}_2\text{O}_3$  enthält, durch Mischen eines Molybdänaluminumsilicids  $\text{Mo}(\text{Si}_{1-y}\text{Al}_y)_2$  mit  $\text{SiO}_2$ , wobei das  $\text{SiO}_2$  wenigstens zu 98% rein ist.
2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass das  $\text{SiO}_2$  in Silikaten vorliegt, wie beispielsweise Mullit und Sillimanit, welche keine Auswirkung auf die Symmetrie des Kristallgitters des Molybdänsilicids haben.
3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass veranlasst wird, dass x im Bereich von 0,4 bis 0,6 liegt.
4. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass veranlasst wird, dass x im Bereich von 0,45 bis 0,55 liegt.
5. Verfahren nach Anspruch 1, 2, 3 oder 4, gekennzeichnet durch teilweises Substituieren des Molybdäns durch Re oder W in dem Material  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$ .
6. Elektrisches Heizelement, welches im Wesentlichen aus dem Molybdänsilicid-Typ und Legierungen dieses Grundmaterials besteht, dadurch gekennzeichnet, dass das Element in der Hauptsache aus den Materialien  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  und  $\text{Al}_2\text{O}_3$  besteht, wobei  $\text{SiO}_2$  mit einer Reinheit von wenigstens 98% während des Herstellungsprozesses zugefügt wird.
7. Heizelement nach Anspruch 6, dadurch gekennzeichnet,

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zeichnet, dass  $x$  im Bereich von 0,4 bis 0,6 liegt.

8. Heizelement nach Anspruch 7, dadurch gekennzeichnet, dass veranlasst wird, dass  $x$  im Bereich von 0,45 bis 0,55 liegt.
9. Heizelement nach Anspruch 5, 6, 7 oder 8, dadurch gekennzeichnet, dass Molybdän in dem Material  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  teilweise durch Re oder W ersetzt wird.

caractérisé en ce que

$x$  est amené à se situer dans un intervalle de 0,45 à 0,55.

9. Élément chauffant selon la revendication 5, 6, 7 ou 8, caractérisé en ce que le molybdène présent dans le matériau  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  est partiellement remplacé par du Re ou du W.

#### Revendications

1. Procédé de fabrication d'un élément chauffant essentiellement constitué d'un type de siliciure de molybdène et d'alliages de ce matériau de base, caractérisé en ce qu'on produit un matériau contenant essentiellement  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  et  $\text{Al}_2\text{O}_3$  par mélange d'un siliciure d'aluminium et de molybdène  $\text{Mo}(\text{Si}_{1-y}\text{Al}_y)_2$  avec  $\text{SiO}_2$ , la pureté du  $\text{SiO}_2$  étant d'au moins 98%.
2. Procédé selon la revendication 1, caractérisé en ce que le  $\text{SiO}_2$  est présent dans des silicates, tels que la mulite et la sillimanite, qui n'affectent pas la symétrie du réseau cristallin du siliciure de molybdène.
3. Procédé selon la revendication 1 ou 2, caractérisé en ce que  $x$  est amené à se situer dans un intervalle de 0,4 à 0,6.
4. Procédé selon la revendication 1 ou 2, caractérisé en ce que  $x$  est amené à se situer dans un intervalle de 0,45 à 0,55.
5. Procédé selon la revendication 1, 2, 3 ou 4, caractérisé en ce que l'on remplace, en partie, le molybdène par du Re ou du W dans le matériau  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$ .
6. Élément chauffant électrique essentiellement constitué d'un type de siliciure de molybdène et d'alliages de ce matériau de base, caractérisé en ce que l'élément est principalement constitué des matériaux  $\text{Mo}(\text{Si}_{1-x}\text{Al}_x)_2$  et  $\text{Al}_2\text{O}_3$ , et du  $\text{SiO}_2$  d'une pureté d'au moins 98 % est ajouté lors du processus de fabrication.
7. Élément chauffant selon la revendication 5, caractérisé en ce que  $x$  se situe dans un intervalle de 0,4 à 0,6.
8. Élément chauffant selon la revendication 7,

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**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

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